tion, but, owing to the separation of their constituent elements, the details of the osteology can be studied, except in the case of the skull, which is often badly crushed, as if they belonged to modern reptiles. It should be added that this full acquaintance with the osteology of these saurians is largely due to the extreme care exercised by Mr. Leeds in extracting them from the matrix.

The remains are generally supposed to have been laid down in rather deep water, but the association of the marine forms with terrestrial dinosaurs, and perhaps also the occurrence of masses of lignite, suggests that the deposit was formed near a coast, and not improbably represents the mud-banks in the delta of a mighty river. Here Ophthalmosaurus, the single and most highly specialised representative of the ichthyosaurs, with its powerful caudal fin, pointed head, enormous eye, and porpoise-like body, probably lived in the open sea, where it played the part now assumed by whales and grampuses. Why this particular type should have become practically edentulous, whereas its upper Cretaceous successors were remarkable for their powerful dentition, is somewhat difficult to understand, although, as Dr. Andrews suggests, this feature was probably connected with the nature of its food. Certain features in its organisation suggest that it was capable of "sounding" to considerable depths.

In marked contrast to the movements of this ichthyosaur were those of the contemporary plesiosaurs, which were far more specialised types than their forerunners of the Lias. Instead of being driven through the water by the screw-like action of a powerful tail-fin, these appear to have rowed themselves on or near the surface by means of their strong paddles, of which the hind pair was nearly equal in capacity to those in front, whereas the tail was short, and provided, at most, with a rudimentary fin. Their whole organisation indicates that they haunted the neighbourhood of the coasts, whereas their short-necked and more strongly built relatives the pliosaurs may be assumed to have ventured further out to sea, although they did not possess the truly pelagic habits of the whale-like ophthalmosaur. The littoral habits of the plesiosaurs exposed them to much more varied conditions of life than was the case with the last-named reptile; and it was these diverse conditions which probably led to the differentiation of the group into the numerous types so well described in the volume before us.

To follow the author through his survey of the osteology of the groups forming the subject of this volume would demand much greater space than the editor is disposed to grant. Attention may, however, be directed to the figure on p. 12 illustrating the form and arrangement of the constituent bones of the occipital region of the ophthalmosaurian skull, and more especially to the remarkable position and relations of the opisthotic and stapes. The great length of the parasphenoid element (p. 15) is also noteworthy, while of even greater interest is the author's reference of the ichthyosaurian humerus to its proper side of the body (p. 52). Among the plesiosaurs it must suffice to refer to the determination of the relations and form of the clavicles and interclavicles, and especially the gradual waning of the latter (compare Figs. 61, 62, 70, 88).

Dr. Andrews has a good deal to say as to the phylogeny of the ichthyosaurs, for which readers must refer to the work itself; that of the plesiosaurs and pliosaurs is reserved for the second volume, which we hope to welcome before many months are past.

(2) Passing on to the guide-book to the fossil reptile and fish galleries, the mere fact that a new edition has become necessary after the lapse of only five years from the issue of its predecessor (which was entirely re-written), affords sufficient evidence that the work meets the requirements of the class of visitors for whom it is intended. As we are told in the preface, the new edition is practically a replica of the eighth issue, and therefore demands no special notice in this place. It may be noticed, however, that the price has been raised from sixpence to ninepence, at which figure the work is still a marvel of cheapness. In the next edition it might be well to explain the meaning of "type" specimens (*vide* preface), of which the general public has no conception, and likewise to amend the legend to Fig. 39, which states that the specimen belongs to a small tortoise, whereas it is really something like twenty inches in length.

R. L.

ELECTRO-CARDIOGRAMS.

Das Elektrokardiogramm des gesunden and kranken Menschen. By Prof. Friedrich Kraus and Prof. Georg Nicolai. Pp. xxii+322. (Leipzig: Veit and Co., 1910.) Price 12 marks.

THE electrical phenomena of the living heart has been a fascinating study among physiologists since the early days of electro physiology; information has been gathered with greater and greater accuracy as apparatus and methods of investigation became more and more refined, and now the registration of the electrical changes in the heart may be, and is, practically employed in the diagnosis of heart affections in the wards of the hospital. A full discussion of the origin and progress of method in this direction is given in this book, which has been produced by authors well acquainted practically with all the details of this branch of physiological and clinical inquiry. The progress of research is strikingly shown in a bibliography at the beginning of the work containing a list of 243 papers on the subject, of which no fewer than 131 have appeared since the beginning of 1900.

It is interesting to notice that investigations into the electrical phenomena of the heart are associated at different periods with the invention of special instruments and methods, such as the galvanometers of Matteucci and du Bois Reymond, the differential rheotome of Bernstein, the capillary electrometer of Lippmann, and, still more recently, the string galvanometer of Einthoven. Matteucci, in 1843, was the earliest observer with the galvanometer; then, in 1849, followed du Bois Reymond with his bussole; Köllker

and Müller worked about 1856, Donders about 1872; and at last there were the elaborate researches of Engelmann from 1873 to 1877. Gotch and Burdon Sanderson studied the phenomena of inhibition in the heart of the tortoise in 1877; Bernstein, du Bois Reymond, Engelmann, Hermann, and Burdon Sanderson used the rheotome between 1868 and 1887. Then followed the invention of the capillary electrometer by Lippmann in 1873; it was soon used by Engelmann and Marey, and in 1883 it was employed in research by Burdon Sanderson and Page. Waller, in 1889, was the first to employ the instrument in the investigation of the human heart. The actual oscillations in the tube of the capillary electrometer were photographed on a rapidly moving plate, so as to produce a cardiogram, and with this invention the names of Burch and Burdon Sanderson will be always associated (1890). In more recent times we have the invention of the string galvanometer by Ader in 1897, and perfected by Einthoven, until it must be regarded as by far the most sensitive instrument for the purpose. The instrument, as now constructed, is much more delicate than the original instrument of Ader, while the apparatus had been made complete by the photographic registering apparatus made by various ingenious workers in optics and mechanics.

The accurate interpretation of the electro-cardiogram owes much to Waller, who established important leading principles on which monophasic and diphasic currents can be explained. He also gave a schematic representation of the action currents that can be led off from the living human heart (Fig. 16, p. 45). In the work under notice, there is a full description of the principle and mechanism of the string galvanometer, and an analysis of the curves produced from it (p. 64). The introduction of the quartz fibre has most materially increased the delicacy of the instrument. There can be no doubt that only an expert can use the instrument in a satisfactory manner, as is well illustrated by a study of the diagram of the apparatus in an actual experiment in Fig. 28, p. 89. This method is much more complicated than the simple galvanometer experiments once in vogue in every physiological class-room or laboratory.

Kraus and Nicolai then give a thorough analysis of the electrocardiogram, showing in the diphasic effects groups of electrical oscillations in the curve which are associated with the contractions of the auricle, with those of the ventricle, and with changes occurring also during the diastole of the ventricles and the filling of the auricles. The time relations of all those phenomena can also be accurately determined; indeed, an insight is obtained into the phenomena of the living beating human heart not otherwise possible. They also endeavour to show that those phenomena may be explained or accounted for by our knowledge of the muscular arrangements of the walls of the heart. Without mentioning the old researches of Borelli or the more recent dissections of Pettigrew (to be seen in the museum of the Royal College of Surgeons, Lincoln's Inn Fields), they describe the spiral arrangement of the fibres, the relation of many of the fibres to the papillary muscles, the fibres of Wenckebach (1901) between vena cava and the auricle, and the bundle of His (1893) between auricle and ventricle. Nearly thirty years ago there appeared the classical research of Gaskell (1883) on the heart of the tortoise, which showed the passage of impulses from auricle to ventricle, and was the beginning of much work of great clinical as well as physiological importance. The analysis of many electrocardiograms is given with great care and thoroughness by the authors in chapters vi. to x., and to those the reader must be referred.

The second portion of the work relates to the clinical use of the string galvanometer in the investigation of diseases of the heart and of the circulation. When one considers that the complete apparatus costs from 200*l.* to 250*l.*, and that a special knowledge of electrical appliances is required, it will be evident that the method cannot be expected to come into general use, even in the wards of a well-appointed hospital. Physicians will depend more on mechanical appliances for registering the movements of the various pulses (both venous and arterial) and of the heart itself, a method of sphygmographic investigation that has received a new lease of life by the labours of Mackenzie and others. At the same time it must be admitted that the electrical phenomena give a glimpse of phenomena actually happening in the heart which would escape detection by the mechanical method, as, for example, slight changes in the beat of the auricles, and some phenomena which may account for want of rhthym, as when the auricles and ventricles do not beat in the normal consecutive order. The time relations can also be accurately noted. The authors give many cardiograms well worthy of the study of physicians. These must not be confounded with the tracings that, by other methods, may be obtained of the vibrations of the sounds of the heart. Science must advance, but it is rather disheartening to be obliged to take the view that these elaborate researches have very little to do with the actual treatment of diseases of the heart, and the sufferer whose heart is beating arhthymically will find cold comfort in the certain knowledge that there is some kind of fatty or other degeneration in the fibres of the bundle of His in his cardiac organ.

Since the above was written a valuable paper has appeared in *Heart* by Dr. Thomas Lewis and B. S. and Adele Oppenheimer on "The Site of Origin of the Mammalian Heart Beat; the Pace-maker in the Dog." The researches have been carried out with the string galvanometer, with special reference to the electrical relations of the collection of specialised tissue at the upper caval end of the sulcus terminalis of His. The tissue, or node, as it may be termed, was discovered by Keith and Flack. Dr. Lewis and his co-workers find electrical evidence to show that it is the site of primary activity, that is to say, from it impulses radiate that are the cause of the co-ordinated heart beat. This result, long sought for by other observers, is an important addition to cardiac physiology, while it illustrates the value of the use of the string galvanometer.

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